DOCUMENT RESUME

ED 022 534 PS 001 124

By-White, Sheldon H.

THE HIERARCHICAL ORGANIZATION OF INTELLECTUAL STRUCTURES.

Pub Date Dec 66

Note-13p.; Paper presented at symposium, The Role of Experience in Intellectual Dev., Am. Assoc. for the Advancement of Sci.,Wash., D.C.,Dec.1966

EDRS Price MF-$0.25 HC-$0.60

Descriptors-AGE, BEHAVIORAL SCIENCE RESEARCH, BEHAVIOR CHANGE, *BEHAVIOR THEORIES, *COGNITIVE DEVELOPMENT, DEVELOPMENTAL PSYCHOLOGY, EDUCATIONAL STRATEGIES, GRADE 1, INTELLECTUAL DEVELOPMENT, INTELLIGENCE QUOTIENT, KINDERGARTEN, *LEARNING THEORIES, LITERATURE REVIEWS, *ORGANIZATION, READINESS (MENTAL), TIME FACTORS (LEARNING)

A discussion of the assumptions about the composition of intelligence which underlie preschool intervention efforts today offers theoretical evidence of a hierarchical arrangement of learning processes. International studies on cognitive development have concluded that the emergence of symbolic or conceptual thought occurs at a transitional age between 5 and 7 years, when the child normatively shows "readiness" to learn reading by the usual school methods. Cognitive and psychoanalytical theorists appear to agree that a more mature level of cognitive and emotional organization is superimposed upon a more juvenile level, the latter being inhibited at this time. A concise review of the behavioral development literature supports this general theory. In addition, the range and diversity of behavioral changes between 5 and 7 seem to reflect the impact of schooling. The following question needs investigation: If the necessary maturation can be advanced or retarded by environmental stimulation, should a preschool goal be to advance the time of transition? The implications for educational programs are apparent. One example is the need for some measurement other than IQ changes in evaluating preschool program outcomes. (MS)

U. S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

The Hierarchical Organization of Intellectual Structures

Sheldon H. White

Laboratory of Human Development, Harvard University[1]

Any discussion of the influence of experience on human intellectual development ultimately comes to rest on questions about the composition of intelligence. The intelligence that the intelligence test tests is really a gross estimate of the capabilities of a bewilderingly complicated apparatus serving behavioral adaptation to the environment. Our basic concern lies not with IQ scores but with this underlying apparatus. We analyze its activities as "abilities," as "types" of learning, as reflective of "mechanisms" of cognitive function, but our analyses are crude and open to argument, a series of uncertain hypotheses. Yet there is an orderliness about many of the hypotheses which is of considerable interest.

About 300 years ago, Descartes mixed a tiny amount of neuroanatomy with a great amount of philosophy to assert that the mind of man is a hierarchical system, with a lower portion which is the common property of man and animals and a higher extension which is the unique possession of man. This notion of a hierarchical arrangement has persisted and has slowly become articulated in psychological treatises from that day to this. We now know a great deal that Descartes did not know. We have studies of comparative anatomy and embryology which have indicated what is old and what is new in man's brain; we have neurological and neuropsychological information which has traced connections

[1]Paper presented at symposium, The Role of Experience in Intellectual Development, American Association for the Advancement of Science convention, Washington, D. C., December, 1966.

ED022534
PS001124

between higher and lower brain centers and behavior; we have studies of the postnatal development of the nervous system; we have much information about learning and cognitive processes in child and adult.

It seems significant that the augmentation of our information has led to persistent reassertions of Descartes' hierarchical thesis, each time with more suggestive information, though we have not yet gotten rid of all his philosophy; it is still a speculative assertion. It has been the basis of theoretical writings by Herbert Spencer, by Hughlings Jackson, Romanes, and George Stanley Hall. In our own day, it is best represented on the psychological scene by the writings of Heinz Werner and is, I believe, a significant determinant of Freud's analysis of mental functions. Psychologists have not in recent years been receptive to the thesis, probably because it represents a kind of speculative centralism which behaviorism has been at pains to avoid. Yet one might argue that this metatheory has as long a history, and as good grounds in evidence, as the associationistic metatheory to which psychologists have subscribed.

In its more current versions, the hierarchical thesis sets forth assumptions something like these. The brain is viewed in evolutionary perspective as an arrangement of older and newer, higher and lower structures. While the child at birth possesses a brain which is in gross conformation like that of an adult, there is evidence from studies of myelinization and from studies of electroencephalographic indices to suggest that the brain is not fully mature -- is not fully like that of an adult -- until late adolescence. The thesis suggests that the development of behavior is articulated with the progressive maturation of higher centers of the brain and the reorganization and control

which these higher centers exert upon lower centers and upon behavior. Properties of younger and older patterns of behavior may be linked with the functions of higher and lower centers of the brain. The thesis further asserts that the symptomatology of behavior disorders may reflect the functional dissolution of higher cortical centers to allow for sporadic or permanent control by lower, more juvenile centers.

This point of view may be useful in understanding certain changes in children's behavior between five and seven years of age. Among American workers, the significance of this age range was first noted in learning experiments. During the preschool ages, there are important resemblances between what a child and an animal will do in a discrimination learning procedure. Between five and seven, children appear to break away from animal-like patterns of performance. There are two lines of research, the transposition experiment of Kuenne (1946) and the reversal-shift, nonreversal-shift experiment of the Kendlers (Kendler and Kendler, 1962) in which the behavior which one obtains after seven years of age departs so substantially from animal and preschool performance as to suggest that a reorganization of the mechanisms underlying the learning has taken place. This reorganization has been explained in terms of a mediational hypothesis involving internal stimuli and responses, but there are data which are not reconciled with this hypothesis, and it may be that the learning experiments taken by themselves give us too narrow a window through which to view and fully interpret change in this age range.

If one looks at the developmental literature devoted to ontogenesis of perception, language, problem-solving, intelligence, and so forth, one is struck by the fact that there seems to be a heaping up of seemingly significant

changes in children's behavior in the age range from five to seven years of age. In a review of these transitions published in 1965, their number amounted to 21 (White, 1965); given recent publications and a few unearthings in the older literature, the count today amounts to 31. It is not possible to go over all this literature today, but some sample items may serve to characterize the kind of material which is available.

Item: Research by Boguslavskaya (Zaporozhets, 1961) and by Schopler (1964) has suggested that at about five years of age children pass from a point where the majority of their exploration of play materials is tactual and kinesthetic to a point where such exploration seems predominantly visual. The Boguslavskaya study, done in Russia, involved ratings of behavior of children playing with material set before them on a table. The Schopler study presented children with pairs of choices of play material, one choice more tactual and one more visual, and counted the children's division of time between the choices. In both cases, a progression was traced towards a majority of time spent on visual exploration in the 6-7 year old age range.

Item: A factorial study of longitudinal intelligence test data by Hofstetter (1954) has shown the emergence at age 5 of a new factor, which assumes status as the principal determinant of intelligence from age 5 through to adulthood. Hofstetter interprets this factor by the use of the terms "provisional action," "planning," and "abstract behavior." It seems probable that this factor may relate to a "divergent linguistic ability" factor which Meyers and associates (Meyers et al., 1964) have found emergent at age 6 in a separate study. It seems further probable that the emergence of this new factor or factors may relate to the marked stabilization of intelligence in this age range

to which Bloom (1964) has called attention, and to the maximization of correlations between the IQs of child and parents which occurs at this time.

Item: A study by Dustman and Beck published this year has demonstrated a marked increase in amplitude of evoked occipital potentials to low-intensity flashes of light up to about 5 or 6 years of age and a decrease thereafter (Dustman and Beck, 1966).

Item: Several word association studies (cf. Ervin, 1961) have confirmed a characteristic shift in children's word associations at age 7 from "syntagmatic" to "paradigmatic." The younger child's word associations tend to be syntactically irrelevant to the stimulus words which are presented to him, but the child at 7 begins the practice found among adults of associating verb for verb, noun for noun, adjective for adjective.

Item: A study by Davidson (1935) of the tendency of children to confuse letter shapes with their vertical or horizontal reversals has suggested marked improvement in children's ability to discriminate such pairs as 'n' and 'u', 'd' and 'b', and 'p' and 'q' in this age range. Presumably, the development of this ability might be related to children's accomplishment of a discrimination of left from right, also normatively found in this age range.

Hopefully, this sample may suggest the range and heterogeneity of the observed behavior changes in this age period. One is tempted to say that something important is happening and that all of this evidence may be interrelated to suggest what that something important is. However, there are significant technical problems.

First, one might question whether the sheer number of such reported changes can be given weight. A great amount of developmental research has been concen-

PS 001124

trated in the preschool and early elementary years and it is not surprising that the literature reports a large number of behavior changes in those years. Perhaps a similar massing of research at other age ranges would eventually turn up a similar quantity of apparently significant behavioral transitions.

Second, since schooling begins at age 6, one might argue that the concatenation of experimental effects represents the drawing together of a cultural artifact -- the onset of school has a deep effect on the child, and the child changes markedly in almost any kind of psychological experiment.

These problems cannot be disregarded in any analysis of this sort of material. The first, the suggestion that these findings are an accidental heaping, seems somewhat countered by a singular theoretical importance which has been attached to this age range by a number of theorists who have considered all age ranges. We will shortly discuss these theoretical assertions. The second, that all of these changes reflect the impact of schooling, seems worth considering for individual items.

For example, Suppes (1966) has found that a sensitivity to rotation of forms, which peaks in American schoolchildren in the first grade, does not do so among children in Ghana and he suggests that the American sensitivity may be a product of reading training. It is doubtful that schooling is an artifact for the aggregate of data. First, a good number of these behavior changes begin to show themselves before formal schooling begins. Second, we now begin to have data on samples of children of school age who, for one reason or another, have not been placed in school, and the studies of Price-Williams (1961, 1962) in Nigeria, of Goodnow (Goodnow, 1962, Goodnow and Bethon, 1966) in Hongkong, and of Sigel and Mermelstein (1965) in Prince Edward County all suggest that certain

Piagetian progressions in this age range develop on schedule without schooling.

It is possible to turn the latter argument around and ask whether this series of changes may not say something about the custom of placing children in school at age 6. It is impressive that four major contemporary points of view about child development have each assigned considerable importance to the age range from 5 to 7; each has assigned to this era a major shift in development. The American S-R psychologists, the Russian theorists, Luria and Vygotsky, and Piaget have all examined cognitive development using markedly different procedures. Each has concluded, on the basis of essentially independent evidence, that the emergence of what each seems to construe as symbolic or conceptual thought occurs in the age range from 5 to 7. The Americans think in terms of mediating mechanisms, the Russians in terms of the second signal system, and Piaget in terms of the capacity for concrete operations. However different the view of abstract mental processes, it is noteworthy that all agree about where in ontogenesis their influence is first found.

The fourth developmental theorist, Freud, has an apparently different view of change at this time. He has concluded that the child develops a repression of childhood sexuality, the formation of a superego, and the onset of an amnesia for the memories of earlier years. The essence of all three developments is to create an inhibition of some formerly existing ideas and behavior.

At first glance, the cognitive theorists' assertions about this age range and Freud's assertions would appear to have little in common. However, if one looks at sequence and timing of developmental events which Freud and Piaget and Vygofsky discuss, interesting similarities appear. One might suspect that

the cognitive and psychoanalytic theorists may be emphasizing different facets of the same, broad process -- that is, a process where a more mature level of cognitive and emotional organization is superimposed upon a more juvenile level, the expression of the more juvenile level being inhibited at this time.

This development might best be understood by assuming that it is maturational -- a maturational event which may be advanced or retarded by appropriate environmental stimuation. There is a corticalization process which brings about the sort of structure with which this discussion began -- a hierarchical arrangement with a lower, more juvenile level of cognitive function and a higher, more mature level of cognitive function. In many situations in which either the lower level alone, or alternatively the system of higher-plus-lower, are capable of determining a response, the action of the higher organization predicated upon inhibition of the behavior determined by the lower level.

To justify the assertion of maturation, one must appeal to principles of consistency within and without the body of developmental data. First, the very scope of the observed changes, the fact that they fall into all the chapter-headings of psychology, the fact that no explanation for one will do for all, suggests a maturational event with wide ramifications. Second, a feature of some of the behavior transitions reported between five and seven, is evidence that the more juvenile pattern can reemerge in the behavior of the older child or adult under stress or pathology (e.g., White, 1966). These regressions suggest that the younger system has remained intact within a child or adult who has advanced beyond it. Third, one finds an association in a number of studies between impulsive, short-latency responses and more juvenile behavior characteristics and long-latency responses and more mature behavior characteristics.

Fourth, one may find outlined in theoretical writings of Schilder (1951), Werner (1957) and Flavell (Flavell and Draguns, 1957; Flavell et al., 1958) a microgenetic thesis which asserts that certain peculiar cognitive products of pathology may be understood as a disinhibition, or release, of first-formed responses which nonstressed adults usually inhibit in favor of later-formed responses.

Time is short, and I have been able to do no more than outline a very large body of evidence which might be set forth as consistent with the general thesis, nor have I completely defended or discussed the statement of the thesis. However, I can assure you that a complete presentation of all the evidence would not force belief in the larger conclusions which have been suggested. I am *emboldened to suggest this speculative hypothesis by the fact that this kind of* scheme has been proposed before, because the scheme seems to tie together a large quantity of available information -- indeed, because nothing less than a scheme of this size would hold together all of the intriguing suggestions of interrelationships appearing in contemporary data, and because I believe that something like this scheme is true.

Some scheme like this, some very large scheme, must be developed in order to reason intelligently about the problems of early education. Questions about the effects of early education depend, as was said earlier, upon assumptions about the composition of intelligence. The assumptions underlying preschool interventive efforts today are multifarious, heterogeneous, and hard to compare with one another.

The kind of scheme under discussion might suggest some lines of classification among methods of approach, and it might suggest more exactly what kinds

of research and analysis might bring us along the road to clarification of issues.

First, about the age of the transition. One might ask whether it should be a possible goal of preschool education to advance the transition. This question seems to me analogous to a possible question which might be asked about older children -- whether it should be the goal of primary education to advance the onset of adolescence and thus with it, the onset of the adolescent's ability to perform Piagetian logical operations. First, I am not sure that it could be done (although, certainly, some of the behaviors which are seen at transition might be advanced by specific training), and second I am not sure that early transition is, in itself, a good thing. The child may structure the world in one way before it and in another way after it, and the opportunities on both sides have value.

Second, the age of transition is the age when the child normatively shows "readiness" to learn reading by the usual methods of the school. The term "readiness" may be used in two ways at this time; there may be an end of one kind of readiness as well as the beginning of another. One might argue again for the value of both sides. One might pose a contrast between teaching strategies which tend to foster "before" kinds of experience, such as those of Montessori as opposed to those which tend to foster "after" kinds of competences, such as that of Bereiter. Posing the contrast this way, one might arrive at a more meaningful, testable contrast between preschool philosophies.

A third point. The criterion of early education has usually had to be the IQ test, but no one is very happy about it. An increase in an IQ score is a socially very acceptable thing to have produced, but no one is fully sure

that increase in IQ is interpretable as a meaningful increase in intelligence, or that a prompt deflection in an IQ score is the only meaningful achievement by which a preschool's efforts can be gauged. Beyond that, the one-shot IQ score gives a preschool teacher almost no detail about what he is doing right and what he is doing wrong. The diverse behavior changes in the 5-7 age range, explored and clarified by considerably further research, might offer a subtler, broader definition of outcomes of early education and some sense of how to see progressions towards those outcomes.

One final point, which has intrigued me, and which I might offer in a paper already hopelessly given over to speculation. If one is going to borrow a little Freud to understand cognitive development, one might be tempted to borrow a little more and consider the possibility of an "educational neurosis" arising from inadequate stimulation in the early years, to be countered in later years only by some laborious remedial process which is the educational counterpart of psychotherapy. One realistic possibility occurs to me. Classical learning theory, it seems, best fits the learning of the child before five. It may be that the natural sterotypy of the behavior of the young child, his tendency to get stuck in behavior routines which he performs over and over, might be very adaptive for a creature whose characteristic routes to learning often require sheer repetition and contiguity. The stereotypy of the child seems to abate at about five or six, and it becomes difficult to get an older child to rehearse sensorimotor routines, even though they might be useful to him, because the rehearsal bores him. It may be that the behavior engineering approaches have had some success in producing educational and personality changes because they manage to absorb the child in a series of experiences which will reach and change structures in the lower part of this proposed hierarchical system.

References

Bloom, B.S. Stability and change in human characteristics. New York, Wiley, 1964.

Davidson, H.P. A study of the confusing letters "b,d,p,q." J. genet. Psychol., 1935, 47, 458-468.

Dustman, R.E., & Beck, E.C. Visually evoked potentials: Amplitude changes with age. Science, 1966, 151, 1013-1015.

Ervin, S.M. Changes with age in the verbal determinants of word-association. Amer. J. Psychol., 1961, 74, 361-372.

Flavell, J.H., & Draguns, J. A microgenetic approach to perception and thought. Psychol. Bull., 1957, 54, 197-217.

Flavell, J.H., Draguns, J., Feinberg, L.D., & Budin, W.A. A microgenetic approach to word association. J. abnorm. soc. Psychol., 1958, 57, 1-7.

Goodnow, J.J. A test of milieu effects with some Piaget tasks. Psychol. Monogr., 1962, 76, #36.

Goodnow, J.J., & Bethon, G. Piaget's tasks: The effects of schooling and intelligence. Child Develpm., 1966, 37, 573-582.

Hofstaetter, P.R. The changing composition of "intelligence": A study in T-technique. J. genet. Psychol., 1954, 85, 159-164.

Kendler, H.H., & Kendler, R.S. Vertical and horizontal processes in problem solving. Psychol. Rev., 1962, 69, 1-16.

Kuenne, M.R. Experimental investigation of the relation of language to transposition behavior in young children. J. exp. Psychol., 1946, 36, 471-490.

Meyers, C.E., Dingman, H.F., Orpet, R.E., Sitkei, E.G., & Watts, C.E. Four ability-factor hypotheses at three preliterate levels in normal and retarded children. Monogr. Soc. Res. Child Develpm., 1964, 29, Whole No. 96.

Price-Williams, D.R. A study concerning concepts of conservation of quantities among primitive children. Acta Psychol., 1961, 18, 297-305.

Price-Williams, D.R. Abstract and concrete modes of classification in a primitive society. Brit. J. educ. Psychol., 1962, 32, 50-61.

Schilder, P. On the development of thoughts. In D. Rapaport (Ed.), Organization and pathology of thought: Selected sources. New York: Columbia, 1951.

Schopler, E. Visual versus tactual receptor preference in normal and schizophrenic children. J. abnorm. Psychol., 1966, 71, 108-114.

Sigel, E.E., Mermelstein, E. Effects of nonschooling on Piagetian tasks of conservation. Paper presented at American Psychological Association convention, September, 1965.

Suppes, P. Mathematical concept formation in children. Amer. Psychologist, 1966, 21, 139-150.

Werner, H. The concept of development from a comparative and organismic point of view. In D.B. Harris (Ed.), The concept of development. Minneapolis: U. Minnesota, 1957.

White, S.H. Evidence for a hierarchical arrangement of learning processes. In L.P. Lipsitt and C.C. Spiker (Eds.), Advances in child development and behavior. (Vol. 2), New York: Academic Press, 1965.

White, S.H. Age differences in reaction to stimulus variation. In O. J. Harvey (Ed.), Experience structure and adaptability. New York: Springer, 1966.

Zaporozhets, A.V. The origin and development of the conscious control of movements in man. In N. O'Connor (Ed.) Recent Soviet psychology. New York: Liveright, 1961, p. 280.